ISO

INTERNATIONAL ORGANIZATION FOR STANDARDIZATION

ISO RECOMMENDATION

R 484

Stone marine in Canada

SHIPBUILDING DETAILS

SHIP SCREW PROPELLERS

MANUFACTURING TOLERANCES FOR CASTING AND FINISHING

1st EDITION
May 1966

Revised in 1980!

3 pts → 9 pts across chord

For each individual country the only valid standard is the national standard of that country.

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Also issued in French and Russian. Copies to be obtained through the national standards organizations.

ATTACHMENT 8

BRIEF HISTORY

The ISO Recommendation R 484, *Ship Screw Propellers—Manufacturing Tolerances for Casting and Finishing*, was drawn up by Technical Committee ISO/TC 8, *Shipbuilding Details*, the Secretariat of which is held by the Nederlands Normalisatie-instituut (NNI).

Work on this question by the Technical Committee began in 1951 and led, in 1958, to the adoption of a Draft ISO Recommendation.

In January 1959, this first Draft ISO Recommendation (No. 269) was circulated to all the ISO Member Bodies for enquiry; it was approved by the requisite majority. However, after a study of the observations relative thereto, the ISO/TC 8 Secretariat decided to submit these observations of the Member Bodies to the Technical Committee during its meeting of October 1960. Taking into account the decision reached during this meeting, the ISO/TC Secretariat drew up a Second Draft ISO Recommendation which was distributed, in January 1964, to all the ISO Member Bodies and was approved, subject to a few modifications of an editorial nature, by the following Member Bodies:

Argentina	Germany	Sweden
Austria	Israel	Switzerland
Belgium	Korea, Rep. of	U.A.R.
Chile	Netherlands	United Kingdom
Colombia	Poland	U.S.S.R.
Czechoslovakia	Romania	
Finland	Spain	

Four Member Bodies opposed the approval of the Draft:

France
India
Italy
Japan

The Second Draft ISO Recommendation was then submitted by correspondence to the ISO Council, which decided, in May 1966, to accept it as an ISO RECOMMENDATION.

ISO Recommendation R 484 May 1966

SHIPBUILDING DETAILS

SHIP SCREW PROPELLERS

MANUFACTURING TOLERANCES FOR CASTING AND FINISHING

1. SCOPE

This ISO Recommendation refers mainly to copper alloy and cast iron screw propellers, of a diameter greater than 800 mm, and making less than 1000 revolutions per minute. It may also be applied to cast steel screw propellers complying with the same requirements.

2. METHODS FOR MEASURING PITCH

Each manufacturer is at liberty to choose his own measuring apparatus. The accuracy of measurement of this apparatus should be at least half of the tolerance on the dimension(s) to be measured, with a minimum of 0.5 mm (see Fig. 1).

The principle of the measurement consists in setting out along the helicoidal line at radius r a certain distance PQ corresponding to the desired angle α and measuring the difference h in the height of the points P and Q with respect to a plane at right angles to the centre line of the propeller shaft. The distance PQ should be measured by making use of one of the methods described in clause 2.1.1, 2.1.2 or 2.1.3.

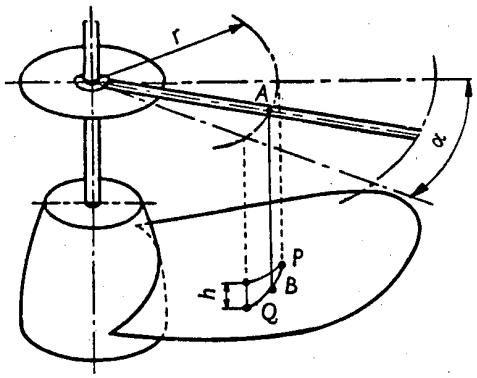


FIG. 1

2.1 Flat section with or without wash-back at leading edge and/or trailing edge

2.1.1 *Use of marking gauges*

The distance PQ should be set out by means of marking gauges.

2.1.2 *Method with graduated ring of small diameter*

The distance PQ should be set out by means of angle α on a part of a graduated ring of small diameter (see Fig. 2).

Errors may occur

at A, as a result of error in measurement of the angle,

at B, as a result of departure from the vertical of the stylus AB.

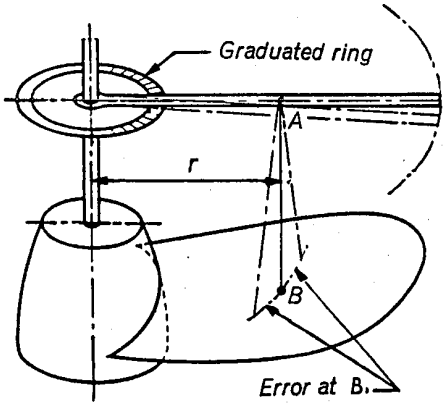


FIG. 2

2.1.3 *Method with graduated ring of large diameter*

The distance PQ should be set out by means of angle α on a part of a graduated ring of a diameter equal to or larger than the diameter of the screw propeller (see Fig. 3).

The possible error at A is considerably reduced.

The possible error at B is not affected.

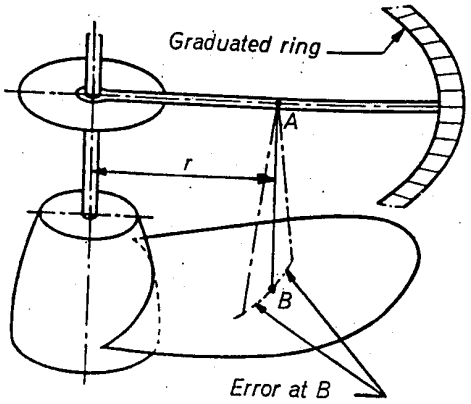


FIG. 3

2.2 Hollow section

Use may be made of the method described in clause 2.1.2 or the method described in clause 2.1.3, if their accuracy is sufficient. Otherwise the method described in clause 2.1.1 should be used.

The mean pitch can be determined from the difference in height between the two points C and D on the profile chord.

This chord is the common tangent to the leading edge trace and the trailing edge trace of the developed cylindrical section of the screw propeller blade (see Fig. 4).

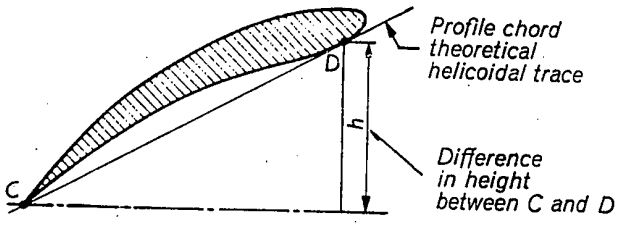
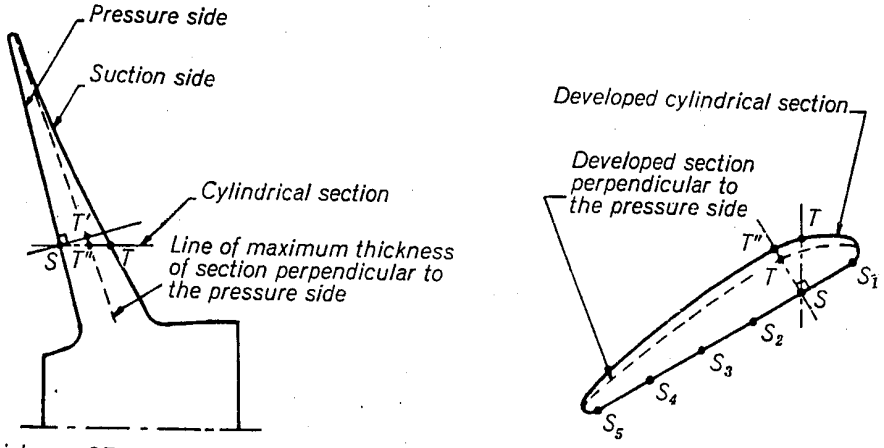


FIG. 4

3. METHODS FOR MEASURING THE THICKNESS OF THE SECTION

The thickness should be measured parallel to the centre line of the screw propeller shaft (ST) or perpendicular to the pressure side of the blade of the screw propeller (ST'). Each manufacturer is at liberty to choose his own measuring apparatus. The accuracy of the measuring apparatus should be at least half of the tolerance on the dimension(s) to be measured, with a minimum of 0.5 mm (see Fig. 5).



Thickness ST measured parallel to the centre line of the screw propeller shaft or thickness ST' measured perpendicular to the pressure side of the blade

FIG. 5

2.1.3 *Method with graduated ring of large diameter*

The distance PQ should be set out by means of angle α on a part of a graduated ring of a diameter equal to or larger than the diameter of the screw propeller (see Fig. 3).

The possible error at A is considerably reduced.

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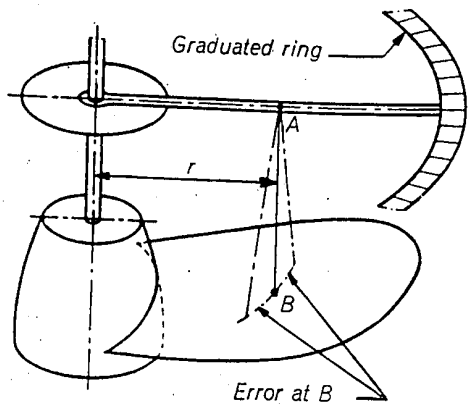

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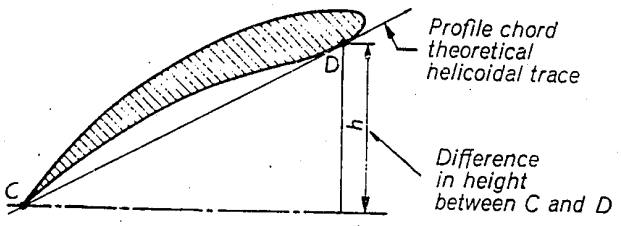

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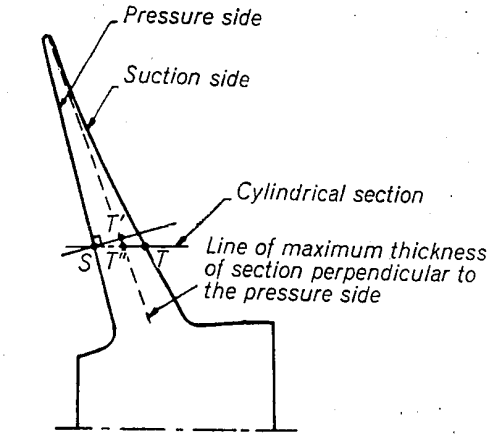


Thickness ST measured parallel to the centre line of the screw propeller shaft or thickness ST' measured perpendicular to the pressure side of the blade

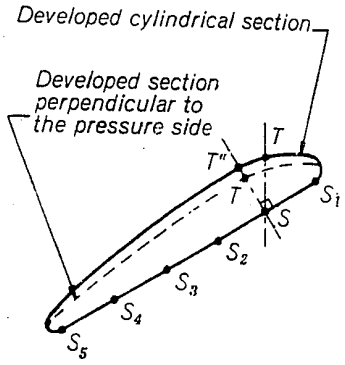


FIG. 5

For checking of the leading and trailing edges, use can be made of section templates, bent cylindrical with a length of 15% of the length of the corresponding cylindrical blade section, with a minimum length of 100 mm and a maximum length of 200 mm.

Checking of the leading and trailing edges with templates is required for classes S and I (see Table 1 below). For the other classes, it may be required by special request of the user.

The maximum thickness at each radius should be determined with a pair of outside calipers or from the profile obtained by plotting the thicknesses at various points S, S_1, S_2, S_3, etc.

4. CLASSIFICATION

Choice of the class should be made by the user; the indications in Table 1 below afford guidance for this choice.

TABLE 1

Class	Accuracy of manufacturing	Normal use
S	high precision	screw propellers of superior quality for special purposes
I and II	medium precision	for majority of merchant vessels
III	large tolerances	for vessels without special characteristics

NOTE.—Class III applies in general only to cast iron screw propellers.

5. TOLERANCES ON THE PITCH

TABLE 2

Description	Class			
	S	I	II	III
Local pitch	±1.5%	±2%	±3%	
with a minimum of	15 mm	20 mm	30 mm	
Mean pitch per blade at any radius	±1%	±1.5%	±2%	±5%
with a minimum of	10 mm	15 mm	20 mm	50 mm
Mean pitch per blade	±0.75%	±1%	±1.5%	±4%
with a minimum of	7.5 mm	10 mm	15 mm	40 mm
Total pitch	±0.625%	±0.75%	±1%	±3%
with a minimum of	6 mm	7.5 mm	10 mm	30 mm

NOTES

1. For screw propellers with constant pitch as well as for screw propellers with variable pitch, the pitch of screw propellers according to classes **S, I** and **II** should be measured at least on 5 radii (e.g. $0.3R$; $0.5R$; $0.7R$; $0.8R$; $0.95R$) and for class **III** on 3 radii (e.g. $0.5R$; $0.7R$; $0.9R$). As far as possible the measurements should be taken on at least 3 points on each radius.
2. The tolerances in Table 2 are expressed as percentages of the design pitch at the corresponding radius.
3. The tolerances for the local pitch and the mean design pitch for each radius per blade should be increased by 50 per cent for sections at $0.2R$, $0.3R$ and $0.4R$.
4. Should the screw propeller manufacturer want to compensate for an error in the pitch (within or outside the tabulated tolerances), by means of a suitable alteration in the screw propeller diameter, he may only do so with the user's agreement.
5. On small blades, where the angle corresponding with the length of a blade section is less than 30°, the pitch should be measured directly at a given radius between two points lying just on this side of the trailing edge and on this side of the leading edge of the blade. In this case, it is recommended that the smoothness of the sections be verified by means of templates.

6. The local pitch, at a certain point B (see Fig. 1), should be determined from the difference in height between two measuring points P and Q situated at equal distances from the point B, viz. $BP = BQ$, etc., by multiplying the difference in height by $360/\alpha$. The total distance between the two measuring points (taken by marking gauges) may amount to 50 mm, 100 mm, 200 mm or 400 mm, depending on the width of the blade.

7. The mean pitch per blade at any radius should be determined by multiplying the difference in height between the extreme measuring points by 360° and by dividing it by the corresponding angle.

8. The mean pitch per blade should be defined as the arithmetical mean of the mean pitch values per blade at any radius.

9. The total pitch should be defined as the arithmetical mean of the mean pitch per blade.

6. TOLERANCES ON THE RADIUS OF EACH PROPELLER BLADE

TABLE 3

Description	Class			
	S	I	II	III
Upper and lower deviations	±0.25%	±0.5%	±0.5%	±0.5%
with a minimum of	2 mm	3 mm	3 mm	5 mm

NOTE.—The tolerances in Table 3 are expressed as percentages of the radius of the screw propeller.

1 mm × .03937 inches / mm = inches

7. TOLERANCES ON THE THICKNESS OF THE BLADE SECTIONS

TABLE 4

Description	Class			
	S	I	II	III
Upper deviations	+2%	+3%	+4%	+8%
with a minimum of	2 mm	2.5 mm	3 mm	6 mm
Lower deviations	−1% −.079	−1.5% −.059	−2% −.079	−4% −.158
with a minimum of	1 mm .039	1.5 mm .059	2 mm .079	4 mm .158

NOTES

1. The thickness of each blade should be measured at the same radii as those at which the pitch is measured.
2. The tolerances in Table 4 are expressed as percentages of the *maximum* thickness of the corresponding blade section.

8. TOLERANCES FOR THE PRESSURE SIDE OF HOLLOW SECTIONS

The pressure side of hollow sections should be measured by determining the local pitch at the radii $0.3R$, $0.5R$, $0.7R$, $0.8R$ and $0.95R$ at a sufficient number of points on each of these radii.

The local pitch should be determined from the difference in height between two adjacent points on the pressure side multiplied by $360/\alpha$ (see Fig. 6).

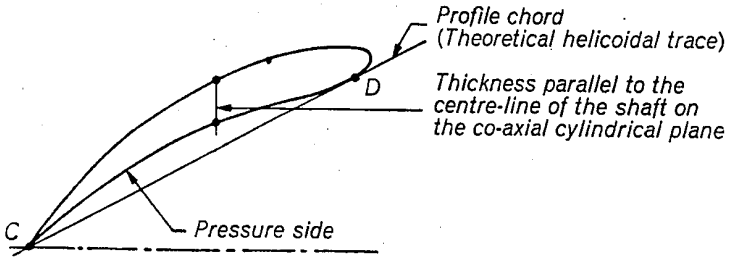


FIG. 6

TABLE 5

Description	Class			
	S	I	II	III
Upper and lower deviations	±1.5%	±2%	±3%	—
with a minimum of	15 mm	20 mm	30 mm	—

NOTE — The tolerances in Table 5 are expressed as percentages of the design pitch at the corresponding radii

9. TOLERANCES ON THE LENGTH OF THE BLADE SECTIONS

TABLE 6

Description	Class			
	S	I	II	III
Upper and lower deviations	±1%	±1%	±1.5%	±2%
with a minimum of	1.5 mm .059	5 mm 0.197	10 mm .393	10 mm .393

NOTES

1. The lengths of the sections of each blade should be measured at 5 radii at least (e.g. 0.3R; 0.5R; 0.7R; 0.8R; 0.95R).
2. The tolerances in Table 6 are expressed as percentages of the length of the corresponding blade section.
3. The tolerances should be increased by 50% for the sections at 0.2R, 0.3R and 0.4R.

10. TOLERANCES ON THE LOCATION OF DESIGN MEDIAN LINES OF THE BLADES

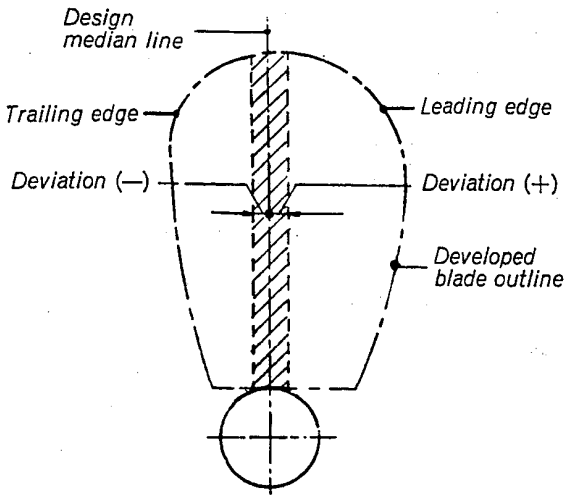


FIG. 7

TABLE 7

Description	Class			
	S	I	II	III
Upper and lower deviations	±0.25%	±0.5%	±0.75%	±1%
with a minimum of	5 mm	10 mm	15 mm	20 mm

NOTE.—The tolerances in Table 7 are expressed as percentages of the diameter D of the screw propeller.

11. TOLERANCES ON THE LONGITUDINAL POSITION OF THE PROPELLER BLADE

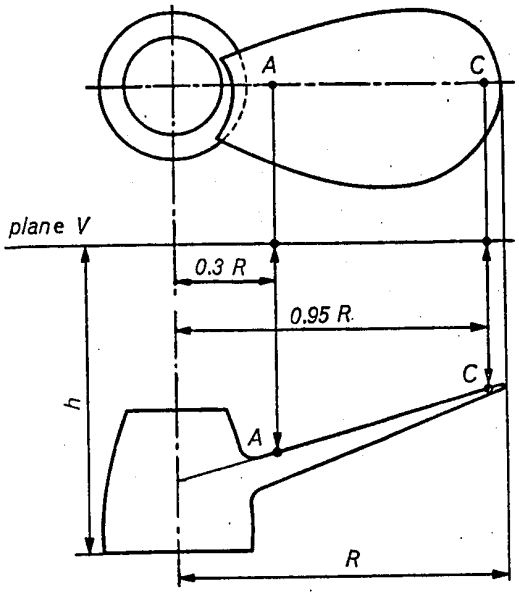


FIG. 8

TABLE 8

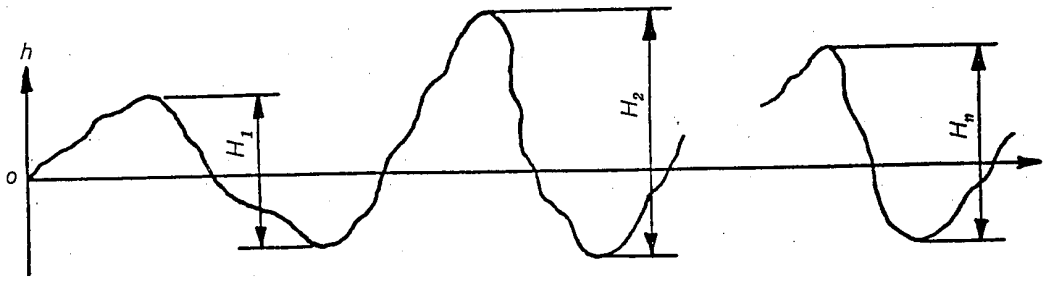
Description	Class			
	S	I	II	III
Upper and lower deviations on the levels of points *A* and *C* on each blade at radii 0.3*R* and 0.95*R* (or the innermost and outermost radii respectively)	±0.5%	±1%	±1.5%	±3%
with a minimum of	5 mm	10 mm	15 mm	30 mm
Upper and lower deviations on the relative level of each blade at point *C* in relation to a plane *V* perpendicular to the centre-line of the screw propeller shaft	±0.5%	±1%	±1.5%	±3%
with a minimum of	5 mm	10 mm	15 mm	30 mm

NOTE.—The tolerances in Table 8 are expressed as percentages of the diameter *D* of the screw propeller.

12. SURFACE FINISH

TABLE 9

Class		
S	I	II
Maximum values of the mean height of roughness, H_m in μm		
3	9	19



The smoothness of the surface of the propeller blades should be determined by the mean height H_m of the surface roughness of the blades at least for the radii of the screw propeller over $0.3R$.

$$H_m = \frac{1}{n}(H_1 + H_2 + \ldots\ldots H_n)$$

μ = micro = 10^{-6}

13. STATICAL BALANCING

When finished, all screw propellers should be statically balanced. The balancing mass g (in kilogrammes) at the tip of the propeller blade is defined by

$$g = c\frac{G}{R}$$

For $n < 160$ revolutions per minute $\quad c = c_k$

For $n > 160$ revolutions per minute $\quad c = c_k \left(\frac{160}{n}\right)^2$

where

g = balancing mass at blade tip, in kilogrammes,

c and c_k = factors depending on the classification of the screw propeller, defined as follows:

Class	S	I	II	III
c_k	1.2	1.8	2.7	5.4
$g_{max.}$	$1.1 \times c_k \times D$ kg			
$g_{min.}$	$0.07\ D^2 + 0.02$ kg			

G = mass of the screw propeller, in tons (1000 kg),

$R = \frac{D}{2}$ = radius of blade tip, in metres

n = number of revolutions per minute of the screw propeller,

D = diameter of the screw propeller, in metres.

NOTE.— The accuracy of measurement of the balancing-apparatus should be at least half of the balancing mass g.